EXPERIMENT AND NON-EXPERIMENTAL SCOPE OF WORK FORM, ANLHEP_644

Date of Submission _06/26/2008_ ☒ New ☐ Renewal ☐ Supplemental Change

Division:	HEP	**Dept./Section:**		**Div. Ref. #:**	
Project Title:	TrICE: TRack Imaging Cherenkov Experiment				
Location (Building/Room, etc.)		TrICE Trailer near Bldg 325, Woods behind 366			
Project dates:	**Start:**	09/2008	**End:**	Till tests done	
Designated Project Manager:		Robert Wagner, Karen Byrum, Gary Drake			

The Project Manager / Principle Investigator must be familiar with the responsibilities and the requirements of the experiment safety review in the *ESH Manual,* Section 21.2.

Work may not be performed until procedures have been approved, and authorization is granted. This completed form, hazard analysis and all supporting documentation must be submitted to the division ES&H Coordinator. Appropriate personnel for ES&H issues associated with the proposed work will review the information. The Project Manager must resolve outstanding issues before the work begins; no work may begin until Approval and Authorization is granted. Approval & Authorization is granted, provided minor code violations are addressed by 12/31/2008

Robert M. Wagner — 6 Oct 2008
Project Manager Approval **Date**

J Thun — 14 OCT 08
Review Approval **Date**

10/14/2008
ES&H Authorization **Date**

H. Weerts — 10/6/2008
Division Authorization **Date**

SCOPE OF WORK (ISM STEP 1)

General Description

Provide an overview description of the experiment (or non-experimental work project). Describe specific equipment for tasks within the project, concentrate on operations that focus on the work, and summarize the hazards that you expect to encounter. Attach designs, drawings, or other useful descriptive material.

This project involves operating a prototype telescope that images Cherenkov light that results from cosmic rays hitting the upper atmosphere. The images are recorded electronically using a data acquisition system. The telescope has been constructed as a prototype instrument to allow the development and testing of a high resolution camera using MaPMTs or other photo detector devices.

The setup consists of two parts: The telescope resides outside, mounted on a steel plate, which in turn is mounted on a concrete pad. A moveable tent mounted on rails normally covers the telescope to protect it from rain, snow, and wind, and can be moved back to expose the telescope camera to the night sky when the telescope is in use. Some of the readout and triggering electronics resides in a front-end relay rack situated directly under the telescope. The second part of the setup is the trailer, which houses the back-end of the readout electronics, computers, etc. The telescope is connected to the trailer through three runs of plastic conduit, approximately 25 feet long, which contain power cables and data cables.

The telescope itself consists of a mechanical structure containing a Fresnel lens and a planar mirror mounted directly above the camera plane. Eight spherical mirrors are arranged on a square perimeter around the base of the fixed structure. Light is collected with the spherical mirrors and focused onto the camera. The camera is mounted on the telescope, and consists of an array of photo-detectors, either MaPMTs or SiPMs. The photo-detectors require a bias voltage to operate, between 70 Volts ~2 kV depending on the device. The telescope includes a trigger system and a data acquisition system for recording the images electronically. The system also has an interlock control system that senses light and moisture, and shuts down the power to the telescope, both AC power and high voltage, in case bright light or a light flash occur, or in case of rain or other moisture. This system protects both personnel and the photo-detectors. Details of these sub systems are described below.

1. High voltage system: The system uses NIM HV modules (Droege or Bertan). Each module has two channels, can supply up to 10kV on each channel and monitor the current at < 100nA resolution. The current on each channel can be monitored with ~1uA resolution. The HV units have a protection mechanism on each individual channel that shuts off the high voltage output if the current exceeds a selectable threshold. The HV modules are interlocked to the moisture/light interlock system, and are shut off in case of moisture or light flashes.

2. Trigger and readout system: The front-end electronics resides in a relay rack situated under the telescope, and contains front-end boards that reside in a 6U VME crate, trigger and timing modules, and low voltage power supplies. The low-voltage power supplies are powered by 110V, 60 Hz power, by power provided from the trailer through the interlock system. The back-end electronics resides in two relay racks inside the trailer, and contains back-end data acquisition boards that reside in a 9U VME crate, and associated power supplies. The high voltage supplies also reside in these relay racks, and provide voltage to the photo-detectors over long cables that run inside the plastic conduit.

(Continued)

3. Interlock system: There are four sensor boxes that are mounted on the top of the telescope

on the four corners. They detect bright light and moisture. Light is measured in 3 directions on each sensor, and covers all directions on the horizon as well as the upward direction. Signals are sent to a control system that resides in the trailer, which has programmable thresholds for each sensor. Both the AC power and the high voltage supplies are connected to this interlock system, and are shut down if the measured light exceeds the threshold, or if moisture is detected. The 110 volt, 60 Hz power provided to the front-end electronics through the interlock system is in turn provided through GFCI circuit breakers. The interlock system operates in a fail-safe mode.

The potential hazards in operating this instrument are electrical shock, and working at heights (when maintenance or adjustment is needed on the telescope camera,) and working in a remote location.

HAZARD ANALYSIS (ISM STEP 2)

Hazard List

Examples include but are not limited to the examples below. You may expand your comment regarding hazard analysis specifics in the scope of work, ISM STEP 1 section of this document.

Low Risk

- ☐ Delivery of items such as furniture, office supplies.
- ☒ Equipment (bench top set up) utilizing hand tools and that does not fall into another hazard classification
- ☐ Equipment repair, de-energized, utilizing hand tools, and that does not fall into another hazard classification
- ☐ Equipment calibration, de-energized, utilizing hand tools, and that does not fall into another hazard classification
- ☒ Computer set-up
- ☐ Installation of window blinds that requires no power tools or use of a ladder
- ☐ Performing office-type tasks
- ☐ Assembly of technical components with use of hand tools and no exposure to additional hazards of a greater risk

Moderate Risk

- ☐ Installation of furniture utilizing power tools, battery operated tools or hand tools
- ☐ Installation of office partitions—including repair and modification to existing partitions, shelving involving no hard wiring of electrical connections, plug type only
- ☐ Installations of carpet with or without utilizing consumer quantity of adhesive product
- ☒ Low voltage calibration/testing—below 50 volts
- ☐ Repair and/or window glass replacement, window cleaning below 6 ft.
- ☐ Repairs that do not require lockout/tagout or use of chemicals that are above a consumer commodity quantity
- ☐ Kitchen appliance repair with out any additional exposure to a high risk activity
- ☐ Activity that does not involve working with any type of energy source, working above 6 ft., or entry into a confined space
- ☐ Painting with latex paint
- ☐ Site survey work that is not within 6' of a roadway and does not include the use of lasers higher than class 2
- ☐ Tree and flower planting in pots or planters
- ☐ Use of class 2 lasers
- ☐ Assembly of technical components utilizing power tools, battery operated tools, or hand tools
- ☐ Assembly of purchased component utilizing power tools, battery operated tools, or hand tools
- ☐ Service of experimental mechanical devices utilizing power tools, battery operated tools, or hand tools
- ☐ Installation of wire cages utilizing power tools, battery operated tools, or hand tools

High Risk

☐ Electrical or other energy sources requiring lockout/tagout for any installation or modification
☐ Working with or having an exposure to hazardous materials (e.g., toxins, carcinogens, asbestos, lead, beryllium, etc.)
☐ Excavations of any type or depth that requires a Dig Permit
☐ Confined spaces
☐ Noise levels above 85 dB
☐ Ionizing radiation (per entry posting)
☐ Non-ionizing radiation (per entry posting)
☒ Working on energized equipment of greater than 50 volts
☐ Installation of office partitions containing electrical hard wire electrical connections
☐ Activity requiring lockout/tagout of energy source
☐ Work on transformers
☒ Working with the potential for a fall from a height greater than 6 ft
☐ Pole work of any nature
☐ Communication tower work including erecting, painting, or inspection
☐ Elevator repair/maintenance/inspection
☐ Overhead crane inspections or repair
☐ Equipment alignment of energized equipment
☐ Sprinkler repairs or modifications
☐ Utility line work on gas line, electrical, water, steam, air, or communication
☐ Mechanical work that may include welding, cutting, burning, or any open flame work, metal grinding, or saw cutting
☐ Concrete boring/cutting/grinding/jack hammering
☐ Hoisting, rigging, or lifting
☐ Parking lot paving and striping
☐ Tree and stump removal, grass burning, or chemical treatments
☐ Laser repair and installation
☐ Painting with epoxy paint
☐ Chiller or refrigerant repair/recovery or replacement
☐ Chemical use (use of flammable products, asbestos abatement, work on lead painted surfaces)
☐ Potential releases to environmental media (air, land, surface water, and/or groundwater)
☐ Equipment use (cranes, fork lift, scissor lift, boom lift, scaffolds, back hoes, bobcats)
☐ Other high risk situations as determined by line management or the division ES&H coordinator

Is this job performed in a location or environment having a special designation where specific precautions are to be observed? ☒ Yes ☐ No

Examples:

(Check those applicable)

☐ Nuclear facility
☐ Nonnuclear radiological facility
☐ Radiological controlled area
☒ Outdoor—NEPA review
☒ Indoor—laboratory, service area, common area
☐ Floor loading limitations

☐ Noise posted area
☐ Laser controlled area
☐ Biohazard area
☐ Magnetic field
☐ Ultraviolet (UV)
☐ Microware
☐ High heat/cryogenics
☐ Hazardous/flammable/reactive chemicals
☒ Energized systems—electrical, pressure
☐ Confined space
☒ Elevated 6 feet or more above working level
☐ Asbestos, lead, mercury, beryllium in area or could be disturbed
☐ Clean room
☒ Other specifically defined locations or environments?

Is this job a complex activity? ☒ Yes ☐ No

Examples:

(Check those applicable)

☐ More than one work group necessary to complete the job.
☒ Steps of a task or tasks of a job must be completed in an exact sequence.
☐ Shutdowns of various systems and lockout/tagouts of various energy sources must be completed.
☐ Life safety features/egress routes altered.
☐ Additional specific training/skills/knowledge/fitness required for those performing task.
☐ Materials handling issues — heavy, bulky, hazardous materials handled individually, with manually operated equipment, with powered equipment such as forklifts, cranes, etc.
☐ Other specific complex activities?

HAZARD CONTROLS (ISM STEP 3)

ENGINEERING CONTROLS

Describe the engineering controls applied to control the hazards. Engineering controls include enclosures and barriers that cannot be removed without the use of tools, interlocks, ventilation, software controls, etc.

Task	Engineering Controls
Use high voltage devices safely	All relay racks are properly grounded. The power system has a central grounding conductor buried in the earth. All AC and high-voltage power provided to the front-end rack is interlocked, and fed from GFCI-protected circuits. All AC power runs are wired with adequately-sized conductors for the size of the over-current protection (circuit breakers.) All high voltage cable runs use appropriate (rated) HV cables and connectors. The high-voltage supplies have a trip mechanism with proper current limit settings. All power supplies have internal fuses on the AC power to protect against short-circuits or faults. All electrical equipment has been inspected for NRTL compliance.

ADMINISTRATIVE CONTROLS

List all work procedures, permits and checklists necessary to mitigate hazards. The Project Manager must describe where skill of the researcher/craft/work is being relied upon for hazard mitigation and control.

Task	Administrative Controls
Use high voltage devices safely	All power supplies are NRTL-certified. The power distribution system is inspected and tested periodically by the project engineer. The telescope is never left unattended when the power is on.
Working at elevations	Training for working at heights is required for personnel working on the telescope.
Working in a remote location	Working alone is not permitted. Workers must use buddy rule.

PERSONAL PROTECTIVE EQUIPMENT

Specify personal protective equipment (PPE) to be worn. For gloves, be specific as to the type appropriate for the task and which steps in the activity the PPE is required.

Task	PPE
Working at heights	When working at heights, a personnel harness is used.

WORKING WITHIN CONTROLS (ISM STEP 4)

All work must be performed within the controls for all the identified hazards.

It is the Project Manager responsibility to verify that this document is kept up to date and determine if changes are significant enough to require a new review/document.

FEEDBACK (ISM STEP 5)

Identify types of records and the reporting method that is useful for improvement on the tasks within this project. This could include lab notebooks, datasheets, computer data, instrument logs, images, etc.

Task/Situation	Record
Emergency	Call 911, take appropriate immediate action (e.g., evacuate space) notify supervisor, building manager, division management, ESH coordinator

Was a graded approach applied to this scope of work? For example, work or experiments involving a few hazards of low severity may not require extensive review. Appropriate review for such may be to have a knowledgeable colleague who will neither supervise nor perform the experiment examine the setup, ISM implementation, and then document his or her conclusions in accordance with division policy for work approval and authorization . ☐ Yes ☒ No

If yes, describe the graded approach taken.

Argonne NATIONAL LABORATORY

Leon T Reed
ES&H Coordinator

High Energy Physics Division
Argonne National Laboratory
9700 South Cass Avenue, Bldg. 362
Argonne, IL 60439-xxxx

1-630-252-4478 phone
1-630-252-5047 fax
1-773-895-7575 mobile
ltr@hep.anl.gov

Date: October 02, 2008

To: H. Weerts Director, HEP

Subject: ***Track Imaging Cherenkov, TrIC Experiment Safety Review Report***

Participants: K. Byrum *(HEP)*, G. Drake (HEP), M. Furlan (EQO), J. Grant (EQO), R. Talaga (HEP), R. Wagner (HEP), K. Wood (HEP)

September 26, 2008, members from the HEP Division Safety Review Committee and ANL Subject Matter Experts conducted an experiment safety review of the TrICE facility.

The site location of the experiment behind Building 366 southeast of Building 325 includes a movable trailer leased from an outside vendor with both electrical and electronic equipment connecting, and supporting the TrICE telescope.

Pending the official report from EQO, and with the exception of some minor National Electrical Code concerns which are fairly standard in commercial industry but not directly applicable for the TrICE R&D facility; there were no life safety findings that would impede the approval for the operations described in the ANLHEP_644, TrICE_092208 scope of work document. The HEP Division grants authorization and approval to operate the TrICE experiment provided that the minor issues, NEC code violations are addressed by 12/31/08.

For reference, see the following comments from M. Furlan and J. Grant; ANL Subject Experts.

ltr@hep.anl.gov

TRICE Comments

1. Rigid Nonmetallic Conduit (RNC)

a. Securing and Support ing requirements. NEC 352.30 (A) requires the conduit to be secured within 3 feet of each outlet box, junction bow, device box, conduit body, or other conduit termination. The larger pipe's clean out needs support following this requirement.

b. Support of Rigid Nonmetallic Conduit. NEC table 352.30(B) requires ½-1 inch RNC to have a maximum spacing of 3 feet between supports, 1 ¼- 2 inch RNC have a maximum spacing of 5 feet between supports, 2 ½ - 3 inch RNC have a maximum spacing of 6 feet between supports and 3 ½ - 5 inch RNC have a maximum spacing of 7 feet between supports.

c. The plumbing pipe is not being used according to its listing. NEC 110.3(B) Installation and Use, requires that a product be installed per its listing requirements. I will as the day to day AHJ allow this installation due to the nature of the wiring.

d. Bushings. NEC 352.46 requires a bushing on a conduit to have a bushing installed to protect the wire from abrasion unless the box, fitting or enclosure provides equivalent protection.

e. Securing and Supporting. NEC 300.11(B) Raceways Used as Means of Support. The raceways can not support other raceways unless they are identified for that purpose. I recommend that a unistrut is staked to the ground and the pipes be secured to that unistrut. The pipes on top of one another need to be ran along side each other.

I suggest that the pipes be run along side of one another with a piece of unistrut underneath staked to the ground. Then the conduits need to be secured to the unistrut at the appropriate intervals.

Experimental Safety Review for TrICE

1. Extension cords
    a. Extension cords are covered in the ES&H manual in section 9.3.4:
        i. **90 Days.** Temporary electrical power and lighting installations will be permitted for a period not to exceed 90 days for holiday decorative lighting and similar purposes.
        ii. **Emergencies and Tests.** Temporary electrical power and lighting installations will be permitted during emergencies and for tests, experiments, and developmental work.
        iii. **Extension cords** must not be:
            1. Attached to building surfaces;
            2. Run through building walls, ceilings, doorways, or windows;
            3. Concealed behind building walls, ceilings, or floors;
            4. Used as a substitute for fixed wiring of a structure;
    b. Applicable sections of the National Electric Code, NFPA 70 2008 edition in Article 400, **Flexible Cords and Cables** are:
        i. 400.7 **Uses Permitted** (A)(6) Connection of utilization equipment to facilitate frequent interchange
        ii. 400.8 **Uses Not Permitted** (1) As a substitute for the fixed wiring of a structure.
        iii. 400.14 **Protection from Damage** Flexible cords and cables shall be protected by bushings or fittings where passing through holes in covers, outlet boxes or similar enclosures. In industrial establishments where the conditions of maintenance and supervision ensure that only qualified persons service the installation, flexible cords and cables shall be permitted to be installed in aboveground raceways that are no longer than 15 m (50 ft) to protect the flexible cord or cable from physical damage.
    c. A case could be made for allowing extension cords as used in the TrICE trailer, as this is developmental work that requires frequent interchange. If allowed, the following changes are recommended:
        i. Bushings or fittings to protect the cords at the point they enter and leave the raceway to the telescope.
        ii. Method of locking out the trailer end of the cords.
    d. The power supplies currently in use would have to be altered to connect them to permanent wiring, and the alterations could introduce a greater hazard than what is being mitigated by eliminating the extension cords.
2. Liquidtight Flexible Metal Conduit, and attachment plug used to run power at the telescope.
    a. Applicable section of the National Electrical Code, NFPA 70 2008 edition in Article 350, **Liquidtight Flexible Metal Conduit: Type LFMC** (A) **Securely Fastened.** LFMC shall be securely fastened in place by an approved means within 300 mm (12 in.) of each box,

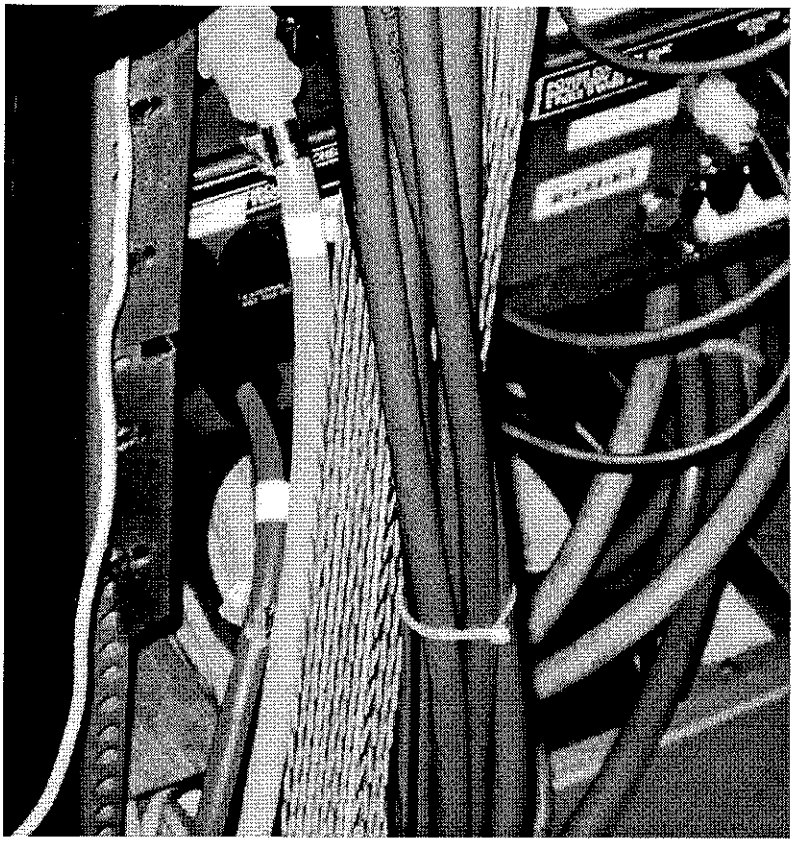
cabinet, conduit body, or other conduit termination and shall be supported and secured at intervals not to exceed 1.4 m (4 1/2 ft). *Exception No. 2*: Where flexibility is necessary after installation, lengths shall not exceed the following: (1) 900 mm (3 ft) for metric designators 16 through 35 (trade sizes ½ through 1 ¼).

b. The attachment plug used is not listed for use with LFMC.
c. Again, a case could be made for allowing this wiring method as necessary to prevent rodent damage to energized conductors. If allowed the following is recommended.
    i. The LFMC should be secured according to the section of the NEC copied above.
    ii. Since the attachment plug was not intended to be used with LFMC it must be evaluated to ensure that makes a secure connection to the LFMC to prevent it from being accidentally pulled loose and exposing energized conductors.

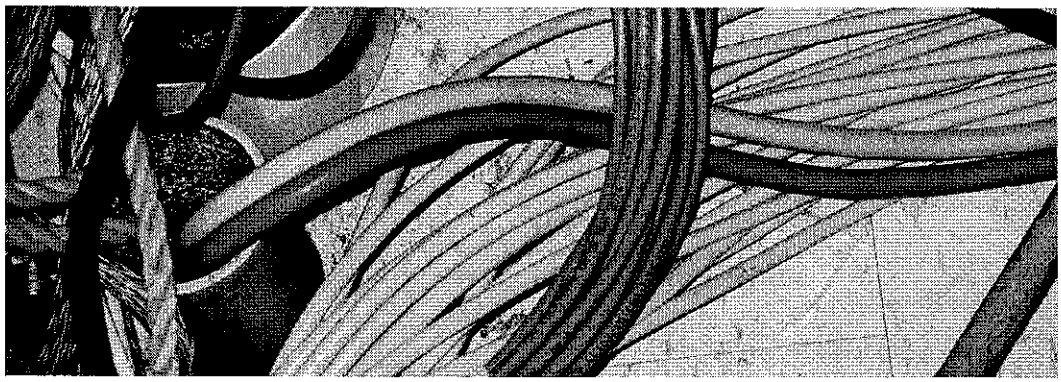
3. Relocatable Power Tap zip-tied to the telescope framework in the tent.
    a. RPTs are also covered in section 9.3.4 of the ES&H manual:
        i. Do not attach RPT's to any structure or rack where tools are needed for removal.
        ii. Do not use outdoors or in wet locations
    b. The RPT in the tent seems to be damaged.
    c. If allowed to be used in an outdoor location, obtain a new, undamaged RPT and attach it in an approved fashion.

Pictures:

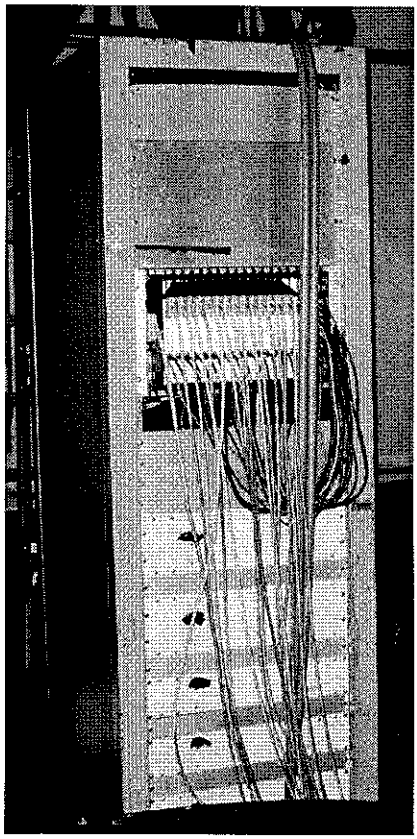
Extension Cords



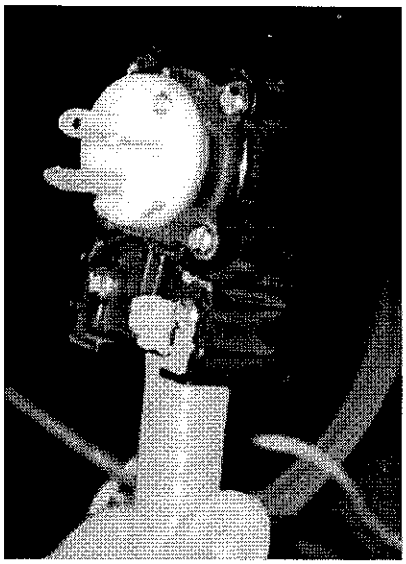
Extension Cords enter Raceway to Tent



Liquidtight Flexible Metal Conduit



Attachment Plug on LFMC



RPT